

# The Materials and Techniques of Tom Thomson

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## The Materials and Techniques of Tom Thomson

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*The materials and techniques of Tom Thomson were studied through the analysis of thirty of his oil sketches and paintings, executed between 1912 and 1917, the year of his death. Instrumental methods employed for the purpose of this analysis were: scanning electron microscopy/x-ray spectrometry, x-ray diffraction, Fourier transform infrared spectroscopy, and polarized light microscopy. Data obtained on the supports, preparation layers, and paint are presented. Thomson painted primarily on small birch panels. When he painted on other supports, he often chose to imitate the colour of wood by applying a light brown priming prior to painting. For works on canvas, he seems to have used mainly linen canvases. His colours were achieved by using complex mixtures of pigments, and he used the same mixtures for both his sketches and paintings. The pigments that were most frequently found are alizarin lake, vermilion, cadmium yellows, cobalt yellow, viridian, and ultramarine.*

*Les matériaux et les techniques de Tom Thomson ont été étudiés par le biais de l'analyse de trente esquisses et tableaux à l'huile, exécutés entre 1912 et 1917, l'année de sa mort. Les échantillons prélevés ont été analysés par microscopie électronique à balayage couplée à la spectrométrie des rayons X, diffraction des rayons X, spectroscopie infrarouge à transformée de Fourier et microscopie en lumière polarisée. Les données concernant les supports, les couches de préparation et la peinture sont présentées. Thomson peignait avant tout sur de petits panneaux de bouleau. Lorsqu'il utilisait un autre type de support, il imitait souvent la couleur du bois en appliquant une couche brun pâle avant de peindre. Lorsqu'il peignait sur toile, il semble qu'il ait peint surtout sur des toiles de lin. Ses couleurs consistaient en de savants mélanges de pigments et il utilisait les mêmes mélanges pour ses esquisses et ses tableaux. Les pigments qui ont été identifiés le plus souvent sont la laque d'alizarine, le vermillon, les jaunes de cadmium, le jaune de cobalt, le vert émeraude et l'outremer.*

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### Introduction

In the early 1910s, a group of artists from the Toronto area founded a new landscape school. The idealistic and nationalistic goal of these young artists was to encourage Canadians to look beyond their colonial roots to their experience of their own country and to move away from an art that relied so heavily on the imitation of European tradition. Among them, Tom Thomson (1877-1917) played a key role in initiating others to the greatness of the Canadian wilderness as a subject matter for painting (**Figure 1**). In 1920, group members Frank Carmichael (1890-1945), Lawren Harris (1885-1970), A.Y. Jackson (1882-1974), Frank Johnston (1888-1949), Arthur Lismer (1885-1969), J.E.H. MacDonald (1873-1932), and Frederick Varley (1881-1969) exhibited together for the first time under the name "The Group of Seven."<sup>1</sup> In the minds of the general public and most art specialists, Thomson is closely associated with the Group of Seven.

Trained in penmanship, Thomson worked as a commercial artist from 1901 to 1913, first in the United States, then in Canada, while pursuing his interest in art. He began working in oil around 1906. In 1912, he made his first trip to Algonquin Park, Ontario, which he depicted extensively in his work for the rest of his career (**Figures 2 and 3**). In 1913, he left his job and started working full time as an artist, with the financial assistance of his patron, Dr. James MacCallum. On July 8, 1917, Thomson drowned in a canoeing accident on Canoe Lake, in Algonquin Park, under circumstances which still remain a mystery.<sup>2-4</sup>

Thomson was a prolific painter. Town and Silcox refer to more than five hundred works, mainly small oil sketches.<sup>5</sup> Silcox explains that: "The speed with which he worked was a factor, and of course he worked in a tiny format most of the time."<sup>6</sup> He further adds: "Even though, according to Jackson, he burned much of his work, an impressive amount remains, considering the short span over which it was done."<sup>6</sup>

Thomson displayed great talent in capturing the mood of the Canadian landscape. The following quote from Silcox suggests why Thomson's art is so cherished by Canadians: "The light on the landscapes Thomson painted was particularly adroit and subtle. One can almost calculate the exact time of day and the quality of the air from the colours he used. This aspect of Thomson's achievement is what charges his work with strong emotion and refinement at the same time. It also is the invisible but pervasive quality which locates his work in Ontario. The light and atmosphere of a locale is unique and Thomson's significance lies in the authenticity with which he captured this feeling and translated it into the language of paint. The Canadian understanding of the landscape was finally complete through his profound sensitivity to it."<sup>7</sup> Thomson's tragic and mysterious death, just before his fortieth birthday, contributed to his fame in Canada. When Thomson began painting, he was criticized for his crude touch and colours and for his realism in depicting what many people at the time considered the most hideous aspects of the Canadian landscape. Today he is one of the most renowned and celebrated artists in Canada, and his work is an essential reference point in Canadian landscape painting.

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**Figure 1.** Tom Thomson in Algonquin Park, Ontario. Photograph courtesy of the Art Gallery of Ontario.

Because of the importance of Tom Thomson's work, the Canadian Conservation Institute (CCI) has undertaken a study of his materials and techniques. In collaboration with the Art Gallery of Ontario (AGO) and the National Gallery of Canada (NGC), thirty oil sketches and paintings were selected and studied. The number of works is small compared to Thomson's total production, however, it was considered a representative sampling since it covers his entire career, with a number of works from each year in which he painted.

The study was primarily concerned with the materials used by the artist, such as the pigments in the paint and the types of supports used, but certain technical details, such as the preparation of the supports, were also examined. The data obtained from the analyses constitute a database that will serve mainly two purposes: to provide a reference for consideration in problems of degradation and conservation treatment, and to respond to questions about attribution and authenticity. Indeed, because of the crucial role played by Tom Thomson in Canadian art, he has been imitated and copied, in some cases with fraudulent intent. Galleries across Canada have been, and continue to be, offered paintings allegedly by Tom Thomson, and several of these have been submitted to CCI for analysis by the scientists of the Analytical Research Laboratory (ARL) prior to being considered for acquisition.

## Experimental

The nineteen sketches and eleven paintings included in the study are listed in **Table I**. Sketches are defined as small works that were done in the field, while paintings are the typically larger works that were done in the studio. In addition to the thirty works included in the present study, three sketches from the National Gallery of Canada that were examined as part of an earlier study are listed in this table: *Rocky Shore*, *Dark Waters*, and a panel painted on both sides entitled *Hills and Swirling Sky*.<sup>8</sup> The limited data available for these sketches have been incorporated with that generated by this study.

Microscopic paint samples were removed from the sketches and paintings included in this study. When possible, the canvas and ground were also sampled. Non-canvas supports were not sampled.

The paint samples were analysed by x-ray microanalysis using a scanning electron microscope equipped with an x-ray energy spectrometer (SEM/XES). X-ray microanalysis was performed using an Hitachi S-530 SEM integrated with a Tracor Xray x-ray detector and a Noran Voyager II x-ray microanalysis system. The SEM was operated at an accelerating voltage of 20 kV.

The samples were subsequently analysed by x-ray diffraction (XRD) to identify the major crystalline components and by Fourier transform infrared (FTIR) spectroscopy. X-ray diffraction patterns were obtained with a Rigaku RTP 300 RC generator equipped with a rotating anode and a cobalt target, using a microdiffractometer and a 100  $\mu\text{m}$  collimator. The generator was operated at 45 kV and 160 mA. The data collection time was two hours. For FTIR spectroscopy, a portion of each sample was mounted in a diamond anvil microsample cell. Spectra of most samples were acquired using a Bomem Michelson MB-100 spectrometer in the range 4000 to 400  $\text{cm}^{-1}$ . Smaller samples were analyzed using a Spectra-Tech IR-Plan microscope accessory interfaced to a Bomem Michelson MB-120 spectrometer in the range 4000 to 700  $\text{cm}^{-1}$ . All spectra were obtained by the coaddition of 200 scans. Most paint samples were examined by polarized light microscopy (PLM) using a Leica DMRX microscope. Pigment dispersions were prepared in Cargille Meltmount ( $n_D = 1.662$ ).

Some samples were made as cross-sections by embedding them in polyester casting resin and preparing them using standard grinding and polishing techniques. The cross-sections were examined by reflected light microscopy using normal and ultraviolet illumination, and analysed by SEM/XES. Fibres from canvas samples were analyzed by FTIR and examined by PLM.

## Results

Thomson painted sketches on boards or wood panels, and occasionally on canvas. He also produced large paintings on canvas. Thomson's painting technique was very bold and direct.

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**Figure 2.** Tom Thomson (Canadian, 1877-1917), *The West Wind*, 1917, oil on canvas, 120.7 cm x 137.2 cm, Art Gallery of Ontario, Toronto, accession no. 784. Gift of the Canadian Club of Toronto, 1926. Photograph courtesy of the Art Gallery of Ontario.

Thick paint, broad brush strokes, and intense colours are very characteristic of his work. His colours range from pastel hues to full, bright colours and deep, dark shades. Many, such as bright reds, oranges and yellows, bright and dark greens, deep and dark blues, purple, burgundy, and turquoise, are found over and over in his works. The following sections give details about the supports, the ground layers, and the pigments in the paint used in the works included in the present study.

### Supports

Nineteen oil sketches and eleven paintings by Thomson were examined. Most oil sketches were done on wood panel. Although the wood species was not characterized as part of the present study, it is generally known that Thomson used birch panels.<sup>2-4</sup> Four sketches were done on board (*Wild Cherry Trees in Blossom*, *Timber Chute*, *Man with Axe (Larry Dixon)*, and *A Northern Lake (AGO 848)*), two on canvas (*The Morning Cloud* and *The Canoe*, the latter being more specifically painted on canvas adhered to wood), one was painted on paperboard (*In the Sugar Bush (Shannon Fraser)*), and one on textured paper adhered to wood (*Drowned Land*).

Murray studied the evolution of Thomson's supports for sketches over the years.<sup>9</sup> According to her, Thomson favoured store-bought 7" x 10" (about 18 x 25 cm) Birchmore boards for his sketches in 1912 and 1913; then in 1914 he switched to slightly larger birch panels or pressed boards of approximately 8½" x 10½" (about 21 x 27 cm) and continued using them until

the end of his life. She also reported that in 1914, Thomson used a poor quality birch panel that later developed vertical cracks; in 1915 and 1916 he used a heavy, grey pressed board, and in the spring of 1917 he cut up old crates to make small 5" x 7" (about 12 x 18 cm) panels.

All eleven oil paintings were done on canvas. As mentioned previously, two sketches were also done on canvas, for a total of thirteen works on canvas. It was possible to sample the original canvas in nine cases, when the paintings or sketches were not lined (or adhered to wood, such as *The Canoe*) or when the lining did not interfere (**Table II**). In all instances, the canvas was identified as linen except for *Autumn's Garland*, where it was identified as cotton. Since it would have been possible to establish the weave and thread count of the original canvas for only a small number of paintings, these parameters were not investigated.

### Preparation Layers

No ground layer was present in any of the oil sketches on wood panel. However, all four sketches on board included a layer of priming that was applied prior to the paint. This layer was coloured yellow ochre in the case of *Wild Cherry Trees in Blossom* and *Timber Chute*, mushroom brown in *Man with Axe (Larry Dixon)*, and salmon pink in *A Northern Lake (AGO 848)*. Murray reported that

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**Figure 3.** Tom Thomson (Canadian, 1877-1917), *Round Lake, Mud Bay*, oil on panel, 21.3 cm x 26.7 cm, Art Gallery of Ontario, Toronto, accession no. L69.51. Photograph courtesy of the Art Gallery of Ontario.

**Table I: Tom Thomson Oil Sketches and Paintings Included in the Study.**

| Title (institution <sup>1</sup> and accession number)  | Size (cm)     | Date        | Type of work | PbSO <sub>4</sub> /ZnO identified |
|--|---------------|-------------|--------------|-----------------------------------|
| <i>Drowned Land</i> (AGO 2449)                         | 17.5 x 25.1   | 1912        | sketch       | -                                 |
| <i>A Northern Lake</i> (AGO 72/25)                     | 69.9 x 101.6  | 1912-c.1913 | painting     | +                                 |
| <i>The Morning Cloud</i> (AGO 70/368)                  | 17.5 x 20.0   | 1913        | sketch       | +                                 |
| <i>The Marsh, Lake Scugog</i> (AGO 2188)               | 27.9 x 43.2   | 1913        | painting     | -                                 |
| <i>Moonlight, Early Evening</i> (NGC 943)              | 52.9 x 77.1   | c.1913-1914 | painting     | +                                 |
| <i>The Canoe</i> (AGO L69.48)                          | 14.4 x 25.3   | 1914        | sketch       | +                                 |
| <i>Northern River</i> (NGC 1055)                       | 115.1 x 102.0 | c.1914-1915 | painting     | -                                 |
| <i>Frost-laden Cedars, Big Cauchon Lake</i> (NGC 4728) | 30.8 x 38.5   | c.1914-1915 | painting     | +                                 |
| <i>Round Lake, Mud Bay</i> (AGO L69.51)                | 21.2 x 26.6   | 1915        | sketch       | -                                 |
| <i>Black Spruce and Maple</i> (AGO 863)                | 21.6 x 26.7   | 1915        | sketch       | +                                 |
| <i>Autumn Birches</i> (AGO 862)                        | 21.0 x 26.7   | 1915        | sketch       | +                                 |
| <i>Wild Cherry Trees in Blossom</i> (AGO 850)          | 21.6 x 26.7   | 1915        | sketch       | -                                 |
| <i>Autumn Foliage</i> (AGO 852)                        | 21.6 x 26.7   | 1915        | sketch       | -                                 |
| <i>Timber Chute</i> (AGO 854)                          | 21.6 x 26.7   | 1915        | sketch       | -                                 |
| <i>Man with Axe (Larry Dixon)</i> (AGO L83.15)         | 21.6 x 26.8   | 1915        | sketch       | +                                 |
| <i>The Pool</i> (NGC 4725)                             | 76.4 x 81.7   | 1915        | painting     | +                                 |
| <i>Silver Birches</i> (AGO L83.14)                     | 22.0 x 27.0   | c.1915      | sketch       | +                                 |
| <i>In the Sugar Bush (Shannon Fraser)</i> (AGO 53/17)  | 26.7 x 21.6   | c.1915      | sketch       | -                                 |
| <i>Pine Tree</i> (AGO 851)                             | 21.6 x 26.7   | c.1915      | sketch       | +                                 |
| <i>Snow in October</i> (NGC 4722)                      | 82.1 x 87.8   | c.1915      | painting     | +                                 |
| <i>Petawawa Gorges</i> (AGO 84/40)                     | 21.4 x 26.7   | 1916        | sketch       | +                                 |
| <i>Rocky Shore</i> (NGC 1535)                          | 21.4 x 26.5   | 1916        | sketch       | +                                 |
| <i>Sketch for The West Wind</i> (AGO L69.49)           | 21.3 x 26.7   | 1916        | sketch       | +                                 |
| <i>Autumn's Garland</i> (NGC 1520)                     | 122.5 x 132.2 | c.1916      | painting     | +                                 |
| <i>Landscape, Sunset</i> (AGO 89/926)                  | 21.1 x 26.8   | c.1916      | sketch       | -                                 |
| <i>Marguerites, Wood Lilies and Vetch</i> (AGO 2563)   | 21.3 x 26.7   | c.1916      | sketch       | +                                 |
| <i>A Northern Lake</i> (AGO 848)                       | 21.6 x 26.7   | c.1916      | sketch       | +                                 |
| <i>Burnt Country</i> (AGO 856)                         | 21.6 x 26.7   | c.1916      | sketch       | +                                 |
| <i>Burnt Land</i> (NGC 4299)                           | 54.6 x 66.7   | c.1916      | painting     | +                                 |
| <i>The Jack Pine</i> (NGC 1519)                        | 127.9 x 139.8 | 1916-1917   | painting     | +                                 |
| <i>Dark Waters</i> (NGC 4660)                          | 21.3 x 26.7   | c.1917      | sketch       | -                                 |
| <i>The West Wind</i> (AGO 784)                         | 120.7 x 137.2 | 1917        | painting     | +                                 |
| <i>Hills and Swirling Sky</i> (NGC 1525)               | 21.5 x 26.6   | unknown     | sketch       | +                                 |

<sup>1</sup>AGO: Art Gallery of Ontario; NGC: National Gallery of Canada

Thomson, starting in 1915, occasionally covered the recto of his boards with what she referred to as an “undercoat” of paint, the colour of which was described as either “terracotta,” “ochre,” “goldenrod,” or “flesh-coloured.”<sup>9,10</sup>

In the case of *Drowned Land*, the sketch that was done on paper adhered to wood, a cross-sectioned sample showed a layer of size (protein, as identified by FTIR) applied to the paper, followed by a ground layer containing lead white, a trace of calcium carbonate, and drying oil.

The canvas preparation was investigated for both sketches on canvas and for all but one painting, *Moonlight, Early Evening*, because, in this case, it proved difficult to safely remove a sample to investigate the ground. On a few occasions it was possible

to see the edges of the canvas and, therefore, to determine if the canvas was commercially prepared or prepared by the artist. This information is provided in **Table II**, although it is of limited use since it was established for a small number of paintings only.

In most paintings the canvas was first covered with a white ground belonging to one of two types (**Table II**). The first type of ground (type I) was found in early paintings (1912-1914). It consisted of calcium carbonate in oil. Such a ground was found in four paintings, and in three of these four paintings another white layer was observed between the calcium carbonate ground and the paint layer(s). Barium, sulfur, and zinc were detected in this layer by SEM/XES, indicating that it contained either lithopone (barium sulfate and zinc sulfide) or a mixture of barium sulfate and zinc oxide.

**Table II: Canvases and Grounds in Tom Thomson Works on Canvas.**

| Title   | Date        | Canvas | Ground*  | Priming       |
|---|-------------|--------|--|---------------|
| <i>A Northern Lake</i>                                | 1912-c.1913 | -      | type I   | white         |
| <i>The Morning Cloud</i>                              | 1913        | -      | type I   | white         |
| <i>The Marsh, Lake Scugog</i>                         | 1913        | linen  | type I   | none observed |
| <i>Moonlight, Early Evening</i>                       | c.1913-1914 | linen  | - (C)  | -             |
| <i>The Canoe</i>                                      | 1914        | -      | type I   | white         |
| <i>Northern River</i>                                 | c.1914-1915 | linen  | type II  | none observed |
| <i>Frost-laden Cedars,</i><br><i>Big Cauchon Lake</i> | c.1914-1915 | linen  | zinc white and charcoal black                      | none observed |
| <i>The Pool</i>                                       | 1915        | linen  | type II (C)  | none observed |
| <i>Snow in October</i>                                | c.1915      | linen  | red earth pigment and calcium carbonate in protein | -             |
| <i>Autumn's Garland</i>                               | 1916        | cotton | type II (A)  | none observed |
| <i>Burnt Land</i>                                     | c.1916      | linen  | type II  | peach         |
| <i>The Jack Pine</i>                                  | 1916-1917   | linen  | type II (C)  | light brown   |
| <i>The West Wind</i>                                  | 1917        | -      | type II  | light brown   |

\*Type I: calcium carbonate in oil; Type II: lead white and calcium carbonate in oil; C: commercially-prepared canvas; A: canvas prepared by the artist.

The second type of white ground (type II) was found in paintings of the later period (1914-1917). It consisted of a mixture of lead white and calcium carbonate in oil. Such a ground was found in six paintings; in two cases it was possible to conclude that the canvas was commercially prepared, but in another case the canvas was prepared by the artist. While in all cases the ground contained lead white and calcium carbonate, the proportions differed with the ground that was applied by the artist containing more lead white and less calcium carbonate. Another feature of the paintings of the later period is the presence, in three out of six paintings, of a priming that was applied prior to the paint. This layer was either a light brown or a peach colour. Within each group of paintings, as defined by the type of ground, a size applied to the canvas, prior to the white ground, was analyzed by FTIR and identified as protein.

In the case of the painting *The West Wind*, it was not certain that the cross-section taken from the painting included all layers. However, the bottom white layer of the cross-section contained lead white and calcium carbonate and was covered with a brown priming layer. This indicates that the ground corresponds to the second type, consistent for a painting that dates from 1917. The light brown priming shows through in places, particularly in the sky and in other areas between brush strokes.

The remaining paintings analyzed were found to have different preparations. The work *Snow in October* had no conventional size, ground or priming, but had instead a reddish preparation layer consisting of a mixture of red earth pigment and calcium carbonate in a protein medium. Finally, the painting entitled *Frost-laden Cedars, Big Cauchon Lake* seems to have been prepared with a grey paint consisting primarily of zinc white and charcoal black.

The results suggest that, starting around 1914-1915, Thomson imitated the tonality of wood when painting on board or a white ground on canvas by applying a wood-coloured priming layer prior to painting. Murray noted how parts of the birch panel showed through the paint and were used as part of the sketch, "a relatively modern way of using the material."<sup>11</sup> Town makes the same observation: "Thomson used the natural wood colour of his birchwood support and occasionally the painted ground as a linear path for the eye between areas of colour. The American artist A.V. Tack pioneered a completely abstract use of this technique in the 1930s and, in effect, the method could be called the intimated line, drawing without brush and, in Milne's case, the divided or third line process. Most of the Group [of Seven] used the natural colour of the panel or a painted ground to separate and neutralize the edge of local colour. None, however, was as instinctively precise and natural in the method as Thomson."<sup>12</sup> Concerning the light brown priming of *The West Wind*, Reid writes: "This duplicates almost exactly the appearance of the sketch where the bare birch panel has been allowed to show through between brush-strokes, particularly around the tree."<sup>13</sup> Therefore, Thomson appears to have carefully selected the colour of the priming to mimic the effect that he achieved with the birch panels.

#### *Paint*

At this time we do not have information from archival documentation about the artist's material suppliers. However, it is more likely that Tom Thomson used commercially prepared paints, as opposed to preparing his paints himself by mixing raw pigments in oil. Most samples proved to be complex mixtures of pigments, and often mixtures repeatedly contained the same major components, with other pigments being present in minor or trace amounts. Some mixtures may have been commercially

**Table III: Pigments Identified in Tom Thomson Oil Sketches and Paintings.**

| Colour                  | Name and Formula  |
|-------------------------|---|
| black pigments          | bone black ( $\text{Ca}_5(\text{PO}_4)_3(\text{OH})$ )<br>charcoal black  |
| white pigments          | Freeman's White (lead sulfate, $\text{PbSO}_4$ , and zinc white, $\text{ZnO}$ )<br>lead white ( $\text{Pb}_3(\text{CO}_3)_2(\text{OH})_2$ )<br>zinc white ( $\text{ZnO}$ )  |
| red and orange pigments | alizarin lake (Pigment Red 83)<br>toluidine red*<br>orange iron oxide<br>red iron oxide (hematite, $\text{Fe}_2\text{O}_3$ )<br>vermilion ( $\text{HgS}$ )  |
| yellow pigments         | cadmium yellow ( $\text{CdS } \alpha$ )<br>cadmium yellow ( $\text{CdS } \beta$ )<br>cadmium yellow ( $\text{Cd}_x\text{Zn}_{1-x}\text{S}$ )<br>cobalt yellow (aureolin, $\text{CoK}_3(\text{NO}_2)_6 \cdot \text{H}_2\text{O}$ )<br>yellow iron oxide (goethite, $\text{FeO}(\text{OH})$ ) |
| green pigments          | emerald green ( $\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 3\text{Cu}(\text{AsO}_2)_2$ )*<br>viridian ( $\text{Cr}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$ )   |
| blue pigments           | cerulean blue ( $\text{Co}_2\text{SnO}_4$ )<br>cobalt blue ( $\text{CoAl}_2\text{O}_4$ )<br>Prussian blue ( $\text{Fe}_4(\text{Fe}(\text{CN})_6)_3$ )*<br>ultramarine ( $\text{Na}_6\text{Ca}_2\text{Al}_6\text{Si}_6\text{O}_{24}(\text{SO}_4)_2$ )  |
| brown pigments          | brown iron oxide (umber)  |

\*Only one occurrence

available, but it is likely that Thomson was further mixing his paints, as is indicated by the diversity in mixtures found in the paint samples. For that reason, no further characterization of the binding medium, identified as drying oil by FTIR spectroscopy in all samples, was attempted using GC-MS. Town reports that the medium of Thomson's paint was usually linseed or poppy oil,<sup>14</sup> but does not specify if this was a deliberate choice by Thomson. This reference may also be interpreted as a general comment about the types of oils that were more commonly used at the time Thomson was painting.

The following discussion will be restricted to the pigments identified in paintings and sketches by Thomson (**Table III**) and how they were used to produce specific colours. Fillers such as calcium carbonate, kaolin, quartz, *etc.*, are not included. In terms of pigments used, no differences were observed between the sketches and the paintings.

#### White pigments

An interesting characteristic of Thomson's work is the frequent occurrence of a mixture of lead sulfate and zinc white, two compounds that were identified together in almost every sample analyzed. Furthermore, x-ray fluorescence spectrometry results

showed that lead and zinc were always present in the same ratio, indicating that the two compounds were not randomly mixed.<sup>15</sup> This mixture corresponds to a white pigment patented by Joseph Benjamin Freeman in England in 1882.<sup>16</sup> Although no specific name was given to this new pigment by Freeman, who referred to it as "an improved pigment," the name "Freeman's White" will be used here. It consisted of a mixture of lead sulfate and zinc white ground under great pressure. In 1885, Freeman obtained a second patent for the improvement of the white pigment previously patented.<sup>17</sup> The improvement consisted of adding barium sulfate to the mixture of lead sulfate and zinc white, achieving greater density, body, and opacity.

The Freeman's White formulation described in the 1882 patent was found in 23 out of 33 sketches and paintings analyzed (**Table I**). In two other works, *Black Spruce and Maple* and *Burnt Land*, zinc white and lead sulfate were identified by XRD or FTIR, but not in the same paint sample. It was thus initially thought possible that zinc white and lead sulfate were used independently and not as the Freeman's White mixture in those two works, but since lead sulfate was recommended for use in watercolour painting only,<sup>18</sup> this possibility was considered unlikely. Since Freeman's White was used as a base and mixed with other colours to achieve specific hues, it is more likely that

the proportions of each of the two components of Freeman's White, lead sulfate and zinc white, changed with respect to the overall composition of the paint sample, and that the amount of one component became too low to be detected by XRD or FTIR.

Since Thomson and the artists of the Group of Seven worked closely together, a survey of the use of Freeman's White in works by fellow artists from the Group of Seven was conducted.<sup>15</sup> Forty-eight sketches and paintings by the Group of Seven were surveyed, and more than 25% of them contained Freeman's White. Sketches and paintings included in the study on the use of Freeman's White were painted between 1912 and 1943 and, regardless of the artist, Freeman's White was identified all through this period. Major pigment manufacturers and artists' materials producers such as Winsor & Newton, Lefranc et Bourgeois, and Koninklijke Talens were contacted, and none ever produced or sold Freeman's White. However, a sample of lead white from Wadsworth, Howland and Co. (an artists' materials supplier in Boston), collected by Forbes in 1924, was found to consist of a mixture of lead sulfate, zinc white, and barium sulfate,<sup>19</sup> which corresponds to the improved formulation of Freeman's White as described in the 1885 patent. Therefore, it is quite possible that Thomson and the Group of Seven did not deliberately chose to use Freeman's White, but rather used it because it was sold as lead white. It should be noted that, during approximately 25 years of analysis carried out by the CCI, Freeman's White has not been identified in any works, Canadian or foreign, other than those of Tom Thomson and the Group of Seven, and that it has not been reported by other conservation laboratories.

Other white pigments identified in Thomson sketches and paintings include lead white and zinc white. In several works, more than one white pigment was found, suggesting that Thomson may have been using different paints from the same manufacturer, or paints from several manufacturers at the same time.

#### Black pigments

Thomson did not use pure black. Rather, mixtures of black and other colours to produce very dark shades of blue, burgundy, or green were used to render black in his sketches and paintings.

#### Coloured pigments

Most paint samples from Thomson works were composed of complex mixtures of several pigments, not to be described in detail in the present paper. The following observations were made.

The pigments that were the most frequently found in significant quantities are: alizarin lake, vermilion, cadmium yellows, cobalt yellow, viridian, and ultramarine. The iron oxide pigments also occurred frequently, but in minor or trace amounts. Cobalt blue and cerulean blue were also commonly found, but not nearly as often as ultramarine. Three pigments were identified

only in one painting, and in only one sample from that painting: toluidine red, emerald green, and Prussian blue.

The cadmium yellows identified were of several types. Both  $\alpha$  and  $\beta$  crystalline forms of cadmium sulfide, CdS, were identified.<sup>20</sup> Cadmium zinc sulfide with different cadmium/zinc ratios was also identified. The various types of cadmium yellow were distinguished by x-ray diffraction. However, when partly amorphous or when present as a minor or trace constituent, cadmium yellow was identified only by polarized light microscopy and it proved difficult to specify the variety. In a number of cases, cadmium carbonate was found together with cadmium sulfide, which suggests that that particular pigment was probably obtained by the dry process in which cadmium metal, oxide, or carbonate is used as starting material.<sup>20</sup> Cadmium carbonate was more often associated with an amorphous form of cadmium sulfide.

The same combinations of pigments were consistently identified in both Thomson's sketches and paintings. Purple consisted of alizarin lake and ultramarine, often with viridian. Greens were typically obtained by mixing yellow and blue pigments with viridian; sometimes several yellow or blue pigments were mixed together. Vermilion was often used with alizarin lake to produce oranges and reds. Ultramarine was usually the major constituent of the blues, with several other pigments added in minor or trace amounts. Only yellows were achieved using a single yellow pigment or a simple combination of pigments.

#### *Signatures and Estate Stamp*

A number of Thomson sketches and paintings were signed in various styles, however, a large number were neither signed nor dated. For example, among the 30 sketches and paintings studied, only four sketches and two paintings were signed; only one work was dated. More often seen is the estate stamp. The stamp was designed by J.E.H. MacDonald around 1919, and was used to stamp the works Thomson left in his studio to authenticate these sketches posthumously. There are two stamps, one a metal die and one of rubber, both in the collection of the National Gallery of Canada. They represent a stylized palette with the initials "TT" and the date "1917." The stamp is usually found on both recto and verso sides of the oil sketches.<sup>9</sup>

Both stamps have been digitally recorded at the National Research Council of Canada (NRC) using a laser scanning system.<sup>8</sup> The data have been compared to laser scanned images of stamp impressions made on original works and were found to match. This can assist us in the detection of fraudulent stamp impressions added to copies or fakes of Thomson sketches. It is important to point out, on the other hand, that the absence of the stamp does not imply that a work is fraudulent, since the estate stamp was used only on works left in Thomson's studio after his death, as mentioned earlier, and not on works sold or given away before his death nor on works belonging to the family.



## Conclusion

Most of Thomson's production consists of sketches on board or birch panel, and he also produced large scale paintings on linen or cotton. When he painted on supports other than wood, Thomson often chose to imitate the colour of wood by applying a light brown priming prior to painting.

Thomson used the same paints for his sketches and paintings. As a base, he often used a white paint containing Freeman's White which was found in more than two-thirds of the works included in the present study. For his colours, Thomson generally used complex mixtures of pigments. Some colours were noted to have been favourites and occurred in many of his works, such as bright reds, oranges and yellows, bright and dark greens, deep and dark blues, purple, burgundy, and turquoise. Many of these colours were obtained by using the same combinations of pigments consistently identified in both Thomson's sketches and paintings. The pigments most frequently found are: alizarin lake, vermilion, cadmium yellows, cobalt yellow, viridian, and ultramarine.

Although using a fairly restricted palette of pigments, Thomson achieved a remarkable range of tones and shades, and created works that are never repetitive, but always vibrant and fresh.

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